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Some General Remarks on the Influence of Climatic Conditions on the Prevalence of Economic Insects in Malaya.

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Do meteorological conditions, other than temperature, affect the biology of insects in a country like Malaya, where the climate is remarkably equable throughout the year? One is naturally inclined to the opinion that their influence is negligible, but in the following note it is shown that wind, rainfall and humidity are of importance in the appearance and disappearance of certain Malayan insects. For example, the cessation of outbreaks of the Coconut Zygaenid, Artona catoxantha, *is undoubtedly influenced by wind and rain. This paper is merely a general one, intended to stimulate interest and to show that detailed observations would be of decided interest.*

One of the factors with which the economic entomologist in Malaya has to contend is the marked uniformity of temperature, and the consequent uniformity in the seasonal distribution of insects. There is no marked dry and wet season in Malaya, as there is in India, nor anything approaching a summer and winter. A perpetual food supply is therefore always available for the continuous breeding of insects, and the control measures practised in other countries during the dry and winter seasons are consequently impracticable here. There are indications, however, that meteorological conditions have a certain influence on insect biology even in Malaya, and in the present note an attempt is made to indicate the main aspects of this influence.

The general climatic features of the country may first be considered. They are illustrated in the diagram, (Fig. 1, A—C) the curves being based on records during 1920—26 (collected and published by the Agricultural Department) from four localities in Selangor State. They may be regarded as more or less typical of the Western side of the Malay Peninsula. The finer details of the rainfall and humidity curves should be disregarded, for reasonable averages are impossible on account of the extremes in monthly variation in various years. Two facts in the diagram, (1 A—B) however, are noteworthy; they are the distinct rise in rainfall from February to May and from July to November, and the drop from April to July, with a corresponding rise and fall in humidity. Slight as these variations are, they appear to have some influence on the prevalence of various insects.

The temperature curve (C) is more accurate in detail than those for rainfall and humidity. It is remarkably constant throughout the year, although naturally highest during the driest months of the year, the range being scarcely two degrees. From the view point of its relation to pest outbreaks, temperature may, therefore, be considered a negligible factor.

Observations would seem to show that wind plays an important part in terminating the outbreaks of insects, but no regular records are available on which to base generalisations.

An interesting feature of the rainfall and temperature of Malaya is its resemblance to that of Ceylon (Fig. 2), where the highest rainfall occurs in almost the same seasons, and the temperature shows only a slight variation.* Both our curves, and those of Williams for Ceylon, would differ materially from most curves which may be plotted for India, where there is a definite hot and cold season and a dry and wet season. Even in Kodaikanal, South India, where the climate is less variable than in many other parts of India, definite hot and cold, and dry and wet seasons, are evident. (Fig. 3). The similarity in climate between Ceylon and Malaya may account in part for the resemblance between their fauna.

So much for the general climatic features of Malaya.

*Cf. Williams, Trans. Ent. Soc. London, 1927, p. 12 (Ceylon) p. 5 (S. India).

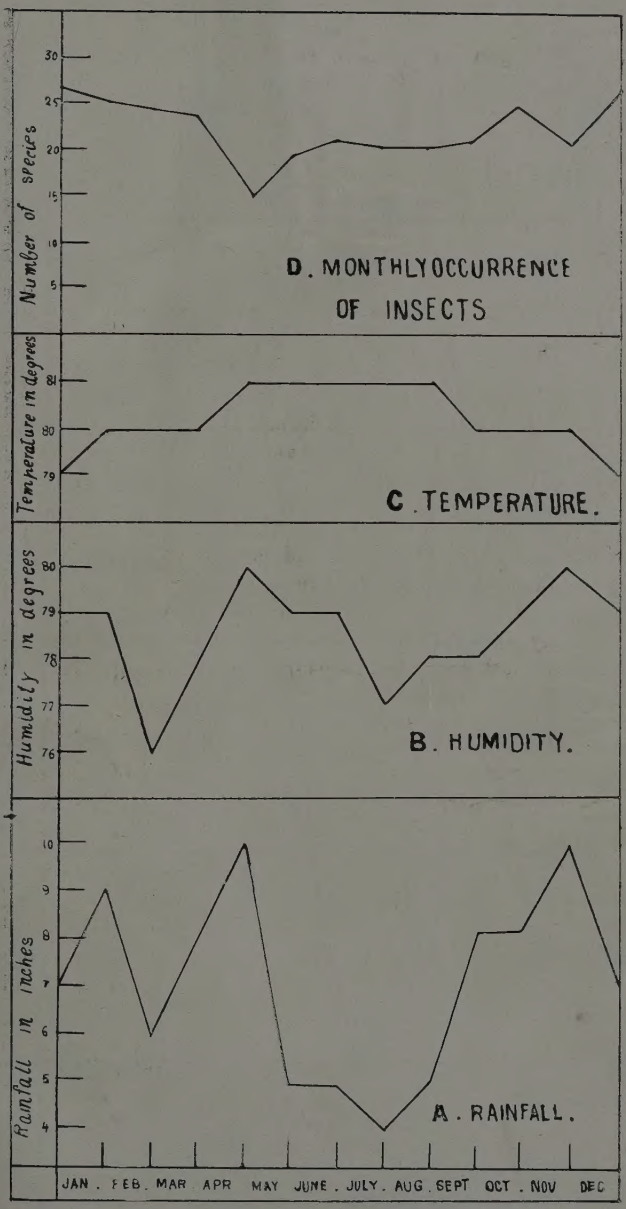

Fig. 1. Showing general climatic features of Selangor State, and the numbers of insect species recorded in each month, out of a total of 38 species studied.

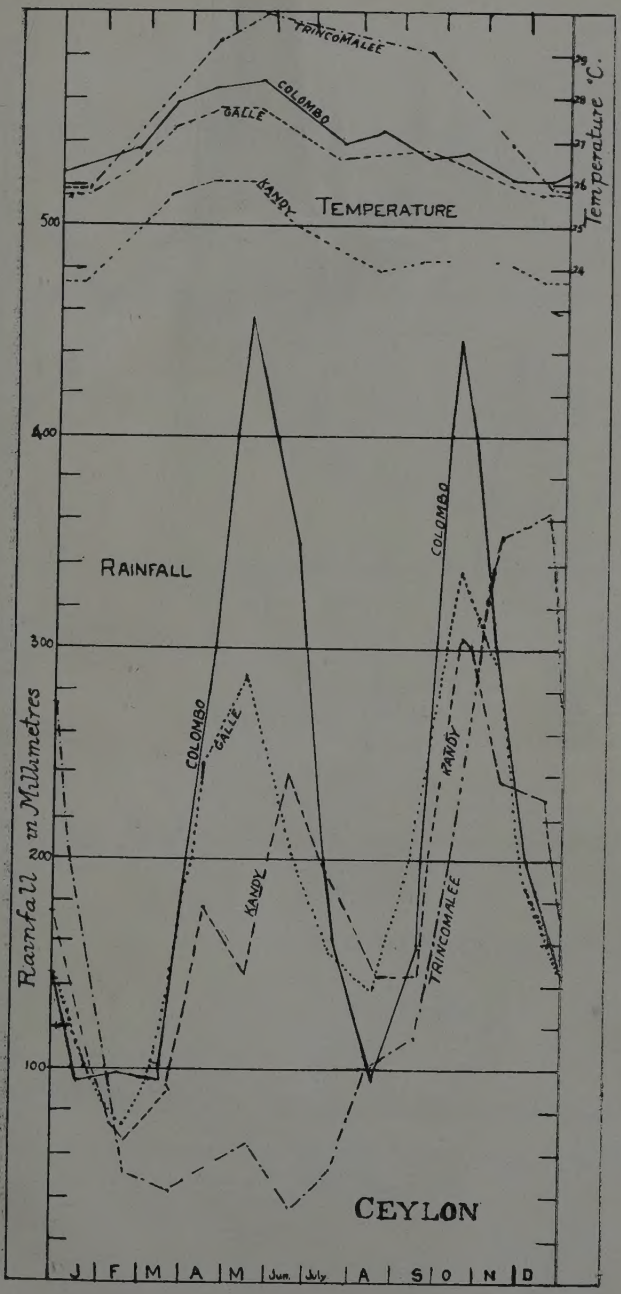

Fig. 2. Showing average rain fall and temperature in several typical localities in Ceylon.
(After C. B. Williams, 1927).

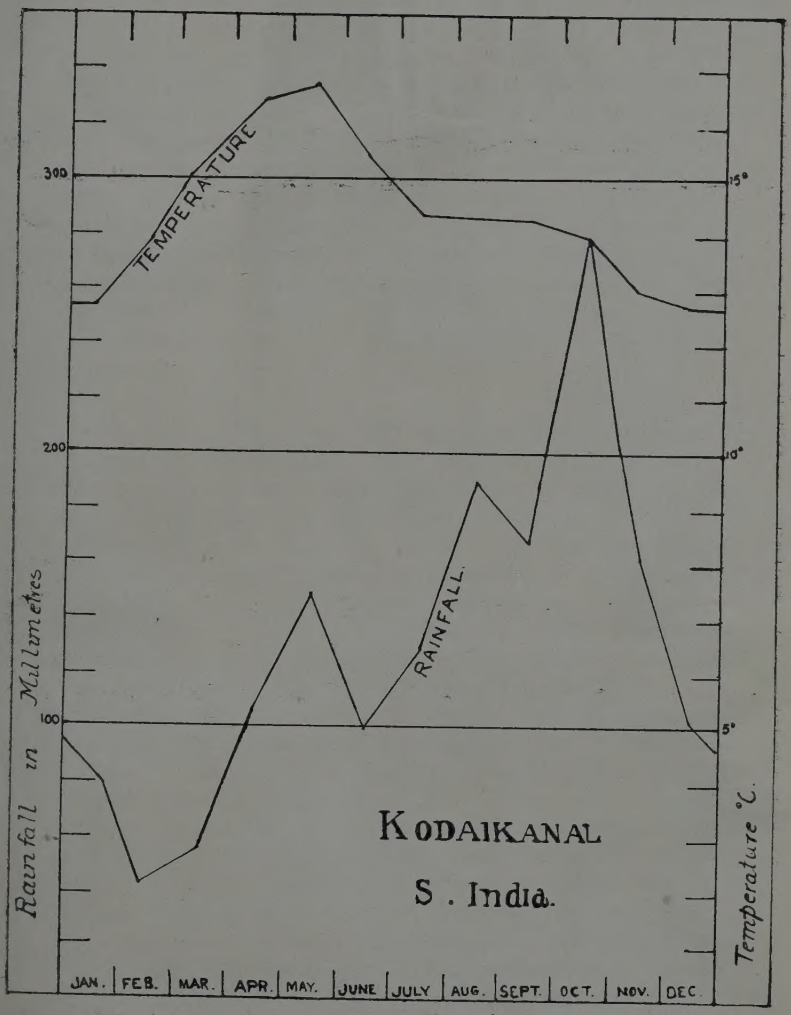

Fig. 3. Showing average rain fall and temperature in Kodaikanal, S. India. (*After C.B. Williams, 1927*).

To what degree do they influence Malayan insects? To ascertain this thirty-eight common species have been selected, and the dates on which they have been received in the Entomological Laboratory during the seven years (1920—26) recorded: the results of this enquiry are shown in the accompanying table. It must be understood that this table is not based on regular collecting (which would probably have shown the occurrence of most of the species throughout the year), but mainly on reports (accompanied by specimens) of species which were proving troublesome to cultivators. Some records are the result of collecting by Malay Officers of the Entomological Section who, however, generally bring in specimens which attract attention by their abundance. The table may, therefore, be regarded as showing fairly accurately the months in which certain insects may be expected to be numerous.

Examining this table it will be seen that the rice insects, *Scotinophara coarctata*, *Leptocorisa acuta*, *Nephotettix bipunctatus*, *Sesamia inferens*, *Spodoptera mauritia* and *S. pecten*, *Chapra mathias* and *Melanitis leda*, have not been recorded during the slight dry season experienced in Malaya when padi is being harvested, a condition one would naturally expect. Of the rice pests, one species (*Nephotettix bipunctatus*) is of particular interest. In India it appears, in company with *N. apicalis*, in hordes, towards the close of the rainy season, and their attraction to light causes them to be extremely inconvenient in houses. So common are these pests that in the early morning a pound of specimens of these "green flies", as they are termed, may easily be collected under a lamp-post in any street in a city like Calcutta. In Malaya, *N. bipunctatus* is comparatively rare, while *N. apicalis* has not yet been taken, though it is said to have a wider geographical range, but even here N. *bipunctatus* preserves its habit of appearing just after heavy rain. An outbreak of some importance was recorded in Krian in December 1925 and January, 1926, meteorological records and personal observations by the Agricultural Field Officer, Perak, (Mr. F. Birkinshaw), showing that it was preceded by abnormally heavy rain. Here we have a species directly affected by rainfall, the climax of its life-cycle being apparently dependent on high humidity. It is this lack of the proper meteorological complex, which is undoubtedly responsible for the comparative rarity of *N. bipunctatus*, and probably for the absence of *N. apicalis*.

Totally different is the influence of heavy rainfall on outbreaks of the Coconut Zygaenid, *Artona catoxantha*. Writing in 1925, Gater (Malayan Agricultural Journal, XIII, p.109) remarks: "As far as the cessation of an attack is concerned there seems to be some connection with rain and wind, since several attacks have been known to stop without any other reason, as far as could be seen, than the start of rainy and windy weather or the breaking of a monsoon. It is doubtful if rain alone has much effect, but in combination with wind it would kill a large number of larvae. A stormy wind beating on the leaves of the palms would tend to make the larvae drop down on their silken threads, and the rain would then wash a large number away or so damage them that they would be unable to reascend the palms". The table illustrates this relation between the cessation of outbreaks of *A. catoxantha* and rainfall very well. It will be seen that outbreaks have been recorded mostly between May and August, the months in which the rainfall is low, and although an outbreak was reported in March it did not continue beyond that month. This outbreak might have commenced during the dry month of February and was not noticed until March. Further observations on this question would be of decided interest, especially as the writers personally believe that rainfall is even more intimately connected with the termination of outbreaks of this serious coconut pest than parasitisation.

Another interesting species is *Papilio demoleus*, a minor pest of *Citrus*, which illustrates the modification of habits caused by different climatic conditions.

In India, it is common during the rains, disappearing almost completely in the dry weather, and there are indications that the species aestivates in the pupal stage. It will be noted that though this species in Malaya preserves to some extent its positive response to wet weather, starting as it does in April, it continues through the driest months of the year, though in lesser numbers, and there is probably no aestivating period.

It will be seen that some of the species which occur throughout the year as pests are either of robust form or constitution, as *Papilio polytes*, *Attacus atlas*, *Prodenia litura*, and *Hypomeces squamosus*, or can subsist on a variety of food, some of which is available throughout the year, as

in the case of the fruit-flies of the genus *Dacus*, and the moth *Lamprosema diemenalis* which occurs on most leguminous plants. The records for *Oryctes rhinoceros* emphasise the reserve with which the table must be treated, as the various stages of this rhinoceros beetle occur in village refuse and similar material throughout the year, though it may be that adults are commonest between June and August.

Summarising the above remarks it would seem that wind, rainfall and humidity have an undoubted influence on certain Malayan insects, in spite of the general uniformity of climate, though in a much lesser degree than in most other countries. This influence may lead either to the appearance or disappearance of a pest, and more precise information as to the nature of this influence would be distinctly useful. On the whole it would seem that most insects of economic importance are commoner during, or just after, the wet weather than in the dry season, though a very heavy rainfall, such as that which occurs in April and November, which is usually accompanied by strong winds, is generally detrimental to the prevalence of insect life. The diagram (Fig. 1 D), in which the monthly occurrences of the thirty-eight species noted in the table are plotted, illustrates this argument.

In concluding it may be pointed out that this paper is intended only to stimulate interest in an interesting subject, and does not pretend to present the results of detailed investigations. The systematic study of the influence of meteorological conditions on outbreaks of insects in Malaya is at present impossible in the Entomological Division, but considerable data could be accumulated if the public would send in insects, with observations on the duration of outbreaks and the existing meteorological conditions.

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TABLE I.

TABLE SHOWING MONTHLY REPORTS OF THE OCCURRENCE OF SOME INSECTS OF ECONOMIC IMPORTANCE.

Based on records obtained between 1920 and 1926 inclusive.

Name of Species.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Valanga nigricornis Burm.	x	x	x	...	...	...	...	...	x	x	x	x
Scotinophara coarctata F.	x	x	x	...	...	...	...	...	...	...	...	x
Leptocorisa acuta Thunb	x	x	...	...	...	...	...	...	...	...	...	x
Leptocorisa varicornis F.	x	x	...	...	...	...	...	...	...	...	...	x
Nephotettix bipunctatus F.	x	...	...	...	...	...	...	...	...	...	...	...
Caprinia conchylalis Guen.	...	...	...	...	...	x	x	x	x	x	...	...
Lamprosema diemenalis Guen.	x	x	x	x	x	x	x	x	x	x	x	x
Psara bipunctalis F.	...	...	x	x	x	x	x	x	x	x	x	x
Psara submarginalis Swin.	...	x	x	...	x	x	x	x	x	...	...	...
Sylepta derogata F.	x	...	...	...	x	x	x	x	x	x	x	x
Parasa herbifera Walk.	...	x	x	...	...	x	...	...	...	...	...	...
Parasa lepida Cram.	x	x	x	...	...	...	...	...	...	...	...	...
Artona catoxantha Hamps.	...	...	x	...	x	x	x	x	...	...	...	x
Cephonodes hylas L.	x	x	x	x	x	x	x	x	x	x	...	...
Attacus atlas L.	x	x	x	x	x	x	x	x	x	x	x	x
Brithys crini F.	...	...	...	...	...	...	...	...	...	x	x	...
Earias fabia Stoll.	x	x	...	...	...	x	x	x	x	x	x	x
Amyna punctum F.	x	x	x	x	x	...	...	...	...	...	x	x
Prodenia litura F.	x	x	x	x	x	x	x	x	x	x	x	x
Sesamia inferens Walk.	...	...	...	...	...	...	...	...	x	...	...	x

TABLE I.—(*Continued*).

TABLE SHOWING MONTHLY REPORTS OF THE OCCURRENCE OF THE INSECTS OF ECONOMIC IMPORTANCE.

Based on records obtained between 1920 and 1926 inclusive.

Name of Species.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Spodoptera mauritia Boisd.	x	x	...	...	...	...	...	...	x	x	...	x
Spodoptera pecten Guen.	x	x	x	x	...	...	...	...	...	x	...	x
Tiracola plagiata Walk.	x	x	x	x	x	...	...	x	...	...	...	x
Chapra mathias F.	...	...	...	...	...	...	...	x	...	x	x	x
Erionota thrax L.	x	x	x	...	x	x	x	x	x	x	...	...
Gangara thyrsis F.	x	...	...	...	...	...	...	...	...	x	...	x
Amathusia phidippus L.	x	x	x	...	...	...	...	...	...	x	...	x
Melanitis leda L.	...	...	...	...	...	...	...	...	x	x	...	...
Papilio agamemnon L.	...	...	...	...	...	x	x	x	x	x	x	x
Papilio demoleus L.	...	...	...	x	x	x	x	...	...	...	...	...
Papilio polytes L.	x	x	x	x	x	x	x	x	x	x	x	x
Epilachna indica Muls.	x	x	x	...	...	...	...	...	...	x	x	x
Plesispa reichei Chap.	x	x	x	x	x	x	x	...	x	x	x	x
Araecerus fasciculatus de Geer.	x	x	x	x	x	x	x	x	x	x	...	...
Hypomeces squamosus F.	x	x	x	x	x	x	x	x	x	x	x	x
Oryctes rhinoceros L.	...	...	...	...	...	x	x	x	...	...	...	...
Chaetodacus cucurbitae Coy.	?	?	x	x	x	x	x	x	x	x	x	x
Chaetodacus ferrugineus F.	x	x	x	x	x	x	x	x	x	x	x	x

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Bye Products of the Pineapple Canning Industry.

V. R. Greenstreet and Gunn Lay Teik.

Pineapple canning has grown during recent years to be an important industry in Malaya. There is an increasing demand throughout the world for canned fruits and as the soil and climatic conditions render possible continuous cropping of pineapples Malaya appears to be in a favourable position to compete successfully with the other fruit-canning countries of the world.

The cultivation of pineapples for canning purposes is peculiarly suitable for Malay small-holders and the produce of native holdings forms a useful adjunct to factory owned plantations, although too much reliance upon native produce is undesirable as supplies are liable to be intermittent. It is important to emphasize the necessity for factories to possess their own plantations as the regularity of supplies bears an important relationship to the employment of canning machinery and the proportion of overhead costs.

The present methods employed in pineapple canning factories are inefficient in two respects. Firstly in respect of the employment of manual labour instead of mechanical contrivances and secondly in respect of the waste matter being a source of expense instead of a source of income. The non-substitution of machinery for manual labour is excusable on the grounds of irregularities in the supplies of raw material but the neglect of bye-products is indefensible.

In Hawaii a vast amount of attention has been paid to the subject of bye-products and according to present methods every scrap of fruit is a source of income. The subject has received consideration from first principles namely the reduction of the fruit parings to an absolute minimum. With this object pineapple varieties are classified according to the depth of their eyes: fruit with deep eyes and irregular shaped pieces are reduced to a pulpy consistency, canned as "sherbet" and supplied to confectioners. The cores and skin after removal of everything suitable for human consumption are ground and pressed, the juice is fermented to produce vinegar and the solid residue either returned to the pineapple plantation where it has been found to be an ideal manure or else dried and marketed as a cattle fodder.

Returning to a consideration of the methods generally employed in Malaya it has been estimated that they involve at present the disposal of about two parts of waste material in the form of cores, skins and rotten and unripe fruits to each part of canned fruit. The waste is thrown upon the floor by the cutters and picked up and removed in baskets by coolies. The baskets are carried by hand to a dump which may be situated as far as fifty or one hundred yards from the factory. The waste material contains about ninety per cent of moisture together with fibre, pentoses, sugars, organic acids and protein matter. The fibrous fraction is tough and hard and rots with difficulty but the softer fraction is exceedingly liable to ferment and putrify thus forming a prolific breeding ground for flies, beetles and other pests. It is obvious that in the course of years thousands of tons of putrid waste must accumulate, the reduction in bulk brought about by the process of putrefaction being insignificant as may be inferred from the following table of analyses of samples drawn from a typical dump at various depths.

TABLE I.

COMPOSITION OF PINEAPPLE WASTE.

——	Fresh Waste	Three feet below surface of dump.	Four feet below surface of dump.	Fresh Waste rotted 4 weeks with 3% Vitic ADCO †
	per cent.	per cent.	per cent.	per cent.
Moisture -	95.4	89.8	89.8	83.4
Mineral ash -	0.34	0.59	0.63	3.53
Organic matter* - (by difference)	4.3	9.6	9.6	13.1
	100.0	100.0	100.0	100.0
*Containing pentoses	2.8	2.5	3.9	3.96
„ nitrogen	0.08	0.2	0.14	0.55

Experiments in the decomposition of pineapple waste using various chemicals have lead to the conclusion that the

† A proprietary mixture for accelerating the rotting of vegetable waste.

factor inhibiting decomposition in the dump is the excessive moisture content which even after the course of years shows no signs of diminution. If the moisture content is reduced by twenty or thirty per cent decomposition proceeds rapidly.

Methods suggested for the disposal of the waste are as follows:—

(*a*) Incineration to produce an ash rich in potash and phosphates and possessing valuable manurial properties.*

(*b*) Producing a cattle food.

(*c*) Spreading the crushed waste on the land in shallow layers when, under aerobic conditions, the occurrence of bacterial decomposition would produce an innocuous soil-like residue amounting to about twenty five per cent of its original weight.

The successful employment of any of these methods requires the material to be partially dried by grinding and pressing. A saccharine liquor is thus produced in addition to the solid matter. The problem of the disposal of the waste therefore resolves itself into devising methods for the utlisation of these two products.

It is conceivable that the combustion of the solid waste according to method (a) would supply sufficient heat for its own drying and for distillation purposes hence this method of dealing with the waste would probably be remunerative. It suffers however from the obvious disadvantage that the organic matter of the pineapple waste is lost to the soil.

Method (b) depends for its success upon the production of a well dried and ground material of more or less uniform composition. It has been demonstrated† in Hawaii that the waste is valuable as a cattle food and since cattle food to the value of $2,000,000‡ is annually imported into the F.M.S. a product such as that manufactured in Hawaii should find a ready market in Malaya. The cattle food marketed under the name of "pineapple bran" which is a sweet smelling granular material is nutritious, rich in vitamines and

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* The ash of a typical sample of pineapple waste was found to contain 5.94 per cent phosphoric acid and 23.75 per cent potash.

† According to Dr. F. G. Krauss, Professor of Agronomy, University of Hawaii "pineapple bran" realises $G22/- per ton.

‡ Commissioner of Trade & Customs, F.M.S. Annual Report, 1926.

particularly suitable for working animals as may be seen by reference to the following analysis of a typical sample:—

TABLE II.

Composition of Hawaiian "Pineapple Bran"*

	Per cent.
Water	10.63
Protein	3.62
Ether Extract	1.01
Invert sugar	11.96
Starch	42.15
Fibre	18.23
Ash	3.70

For the waste to be treated by method (c) it is desirable for it to be efficiently crushed and pressed in order to eliminate most of the sugars which tend to retard decomposition. The method requires for its success the provision of a large area of land where the waste may be decomposed. Even if sufficient land adjacent to the factory were available a great deal of labour would be required while the decomposed material would again have to be loaded on to carts or lorries for return to the pineapple plantations. For the method to be successful therefore, it is essential for the fresh waste to be transported to the pineapple plantation cheaply. It is suggested that this could be effected by returning it in the vehicle which transports the raw fruit to the factory. Since it is more compact than the raw fruit the waste from three or four loads of pineapples could be transported in one return journey. By crushing and pressing the waste from six or even seven loads of fruit could be transported in one return journey. The waste might be loaded in the following manner which would be both inexpensive and expeditious. An endless belt could be used to catch the waste falling from the cutting benches and convey it to the crushing and pressing machines upon issuing from which a second belt could convey it to a hopper situated above the roadway where the lorries discharge. The hopper could be designed to hold several lorry loads and to discharge one load at a time by the movement of a lever.

* From a paper presented before the Hawaiian Academy of Sciences, 1927 by Dr. L. A. Henke, Professor of Agriculture, University of Hawaii.

Reverting to a consideration of the expressed liquid or "juice" the composition of which may be seen by reference to table III, its fermentation to a potable alcoholic liquid such as samsu naturally suggests itself.

TABLE III.

Composition of Juice from fresh Pineapple Waste.

Constituent.	Per cent.
Acidity (as sulphuric acid) ...	... 0.23
Acidity (as acetic acid) ...	... 0.28
Total solids (dried at 100°C) ...	... 8.24
Sugars:—Total (calculated as invert sugar) ...	6.12
Invert Sugar	... 3.14
Cane Sugar	... 2.56

Pineapple juice contains wild yeasts and other bacteria which rapidly produce excessive acidity or sourness. For efficient alcoholic fermentation it was found essential to employ only fresh sterile juice and ferment with rice-cake* or toddy yeast. The following are the details of a typical exerimental trial carried out to ascertain the optimum conditions for the production of a potable alcoholic liquor. Approximately half a gallon of fresh juice was filtered and sterilised by boiling. After cooling one per cent of rice cake was added. Fermentation commenced after 48 hours and was allowed to proceed for a further period of 48 hours when it was practically complete. The amount of unfermented sugar remaining was found to be 0.08 per cent and the alcohol content of the fermented juice 2.64 per cent. As the yield of alcohol theoretically possible is 3.13 per cent, the efficiency of the process is approximately 84 per cent.

Since the commercial fermentation of pineapple juice at its original concentration would necessitate dealing with a relatively large and unwieldy volume of liquid, experiments were carried out to determine to what extent the original juice could be concentrated without affecting the rate of fermentation. It was found that satisfactory fermentation could be obtained by concentrating pineapple juice to approximately 40 per cent of its original volume, that is to say

* A Chinese product containing mucor and yeast and used in the manufacture of samsu for saccharification and subsequent fermentation of rice. It consists of a mixture of cooked rice, soya beans and clay.

raising its sugar content to about 15 per cent. As a result of the success of laboratory experiments it was decided to carry out experiments on a large scale at a canning factory. About 8 gallons of fresh juice from the filter press were concentrated in a large steamjacketed pan to about 40 per cent of its original volume, cooled to about 40°C, transferred to a carboy and toddy yeast added. Fermentation commenced within a few hours and was allowed to continue for 2 days: one gallon of the liquid was distilled and the alcohol content of the distillate found to be approximately 35 per cent.

Table IV shows the alcoholic strength of distilled fermented pineapple juice compared with that of typical samples of brandy and samsu.

TABLE IV.

THE ALCOHOL CONTENT OF DISTILLED FERMENTED PINEAPPLE JUICE, BRANDY AND SAMSU.

Liquor.	Alcohol content per cent by weight.	Proof spirit per cent.
Pineapple -	34.9	73.0
Brandy -	38.5	80.0
Samsu -	27.5	58.0

Summary:—Compared with those employed in Hawaii Malayan methods of pineapple canning are inefficient particularly with regard to the non-economic disposal of waste matter.

For economic disposal of the waste matter removal of the juice by expression is shown to be essential. Remunerative methods of disposal of the partially dried waste are described.

It is shown that the fermentation and distillation of the fresh juice for the production of a potable alcoholic liquor similar to brandy or samsu is a simple process.

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Samsu from Rice.

R. O. Bishop and Gunn Lay Teik.

A brief description is given of the local method of making samsu.

It is shown that the old fashioned process used by the Chinese in Malaya is responsible for a serious waste of rice and that the alcohol which is now produced could be increased by 26 per cent from the same quantity of raw material.

In view of the importance of rice supplies to this country the matter merits further attention and suggestions are made here for simple alterations which would effect improvements in the local methods of manufacture.

Samsu is an alcoholic beverage which is produced from rice. In the local samsu distilleries which are run by Chinese the process of manufacture appears to be very imperfectly understood and the methods in use are those which have been in vogue for several centuries. Owing to the importance of supplies of rice to this country it is desirable to consider the efficiency of a manufacture which is responsible for the consumption of considerable quantities of imported foodstuffs. The Department of Agriculture and the Trade and Customs Department have recently been carrying out observations at a local distillery and in view of the fact that the literature available contains very little reference to the Chinese methods it is considered of interest to place on record the results which have been obtained.

The process adopted by the Chinese for the manufacture of samsu depends upon the utilisation of a mould which secretes a ferment capable of converting moist starch into alcohol. The rice after it has been fermented is distilled and the distillate is sold as samsu without any further treatment.

In actual practice an imported rice is used known as "cargo" rice. This is first boiled in order to soften the grain, it is then allowed to cool and the ferment which is known locally as "rice-cake" is added and roughly mixed. The mixture of rice and rice-cake is placed in earthenware jars, water is added and the jars are allowed to stand for 27 days; at the end of that period the fermented contents of the jars are somewhat like porridge and are ready for distillation.

The distillation is carried out in a primitive apparatus. An open iron pan in a stone setting is heated by direct firing and when hot it is charged with the fermented rice porridge. When the charge is boiling the pan is covered by a tin cylinder which is made in two halves, the upper half can be filled with cold water and in the lower half the vapour from the boiling fermented rice is collected and condensed. The condensate is trapped by a gutter running round the inside of the cylinder. The condensed liquid is led out through an opening in the wall of the cylinder and discharged into an earthenware receptacle.

Before criticising the various stages of the Chinese manufacture it is relevant to refer to the amylo process employed in Europe for the production of alcohol. In 1892 Calmette isolated *Amylomyces Rouxii* from Chinese rice-ferment and the amylo process was developed on scientific lines. The mould originally employed has now been supplanted by other mucors which have been shown to produce less acid and give higher yields of alcohol and this process is now practised to a considerable extent in Belgium and France. Pure cultures of the ferments are used, the raw material e.g. potatoes, maize or rice, is sterilised and fermented under carefully controlled conditions and a very efficient conversion of starch to alcohol is obtained. It is stated that one gramme of the mould used is capable of converting 15 tons of starch into alcohol and the process is complete in 7 days, there are no bacterial side-fermentations and the yield of absolute alcohol is 80 per cent of the theoretical possible.

Referring to the local Chinese practice it is found that the ferment contained in the rice-cake is very variable in its activity and no steps are taken to ensure uniformity in the conditions of fermentation moreover the process is controlled only by rule of thumb methods. It is not surprising therefore that a considerable loss of rice occurs and the fermentation results in acid and other bye products.

Observations have shown that the "cargo-rice" used is that which originates from Loonzain in Burma. It is a partially milled rice, consisting of white and red grains containing a fair proportion of husk. The average starch content is approximately 62.0 per cent.

The rice cake used consists of rice starch, soya beans, clay, some vegetable tissue and variable amounts of mucors and yeasts.

The cake is said to be made in China by allowing rice flour mixed with aromatic herbs to undergo spontaneous fermentation at a moderate heat. White mould grows on the cakes which are then dried in the sun. The finished material contains a great variety of organisms differing in number and species in different preparations but always including a proportion of the mould *Amylomyces Rouxii*. This possesses the property of saccharifying starch and slowly converting the sugar into alcohol. A sample of rice cake examined at the Department of Agriculture was found to contain 40 per cent of mineral matter, and determinations of the starch content have shown that the majority of the cake in use locally contains about 22 per cent starch.

For the manufacture of samsu the local practice is to mix 135 katis of rice with 45 katis of rice-cake. This constitutes one "batch" and is equivalent to 123.5 lbs. of pure starch. The rice is first cooked by heating it with a little water in flat iron pans fixed over open fires. No attempt is made to stir the rice while it is being heated and there is a fair proportion of charred grains in the cooked material. It appears that the importance of gelatinising the starch is entirely unknown and the value of efficient cooking is not realised.

The rice when taken from the cooking pans is almost dry and is carried in baskets to large wooden tables where it is spread out to cool. The cooling is however of short duration and the piece workers whose object it is to deal with as much cooked rice as possible commence to mix in the rice-cake while the temperature is still between 60° and 70° C. Probably no harm is done however for the mixed cake and hot rice is soon shovelled out into the fermenting jars and there cold water is added in the proportion 2 gallons of water to each jar. A slight hand stirring is given to the contents of each jar, about 5 gallons, and they are set aside to ferment for 27 days.

Periodic tests by the Department of Agriculture have shown that the alcohol content of the fermented mash is approximately 8.5 per cent. by weight on the 10th day. Thereafter the rise in alcohol is very slight and the maximum content is not greater than 8.9 per cent. on the 25th day.

Prolonged fermentation appears to improve the fluidity of the mass but observations show that the fluidity reaches a maximum about the 19th day.

When the mass is distilled at the end of the 27th day the solid matter remaining contains approximately 20 per cent. of unfermented starch. In practice one "batch" (see above) yields 19 gallons of liquor containing 25 per cent. alcohol by weight. That is, one *"batch" or 123.5 lbs. of pure starch yields 4.75 gallons of absolute alcohol.*

By calculation the theoretical yield would be 8.85 gallons of absolute alcohol. According to the published information available for good continental practice for the manufacture of alcohol from rice by the same process of fermentation *it is practicable from 123.5 lbs. of pure starch to obtain 6.8 to 7.4 gallons of absolute alcohol.*

Therefore it appears that for every "batch" of rice which is worked at the local distillery at least 1.25 gallons of absolute alcohol is lost; or approximately *26 per cent. of the possible yield.*

In one local factory at which observations were made the number of batches worked per day was 12. The amount of alcohol lost was therefore of the order 16 gallons per day.

The composition of average samples of samsu and comparative figures for the analysis of toddy are recorded in Table 1.

TABLE I

THE COMPOSITION OF LOCALLY MANUFACTURED SAMSU.

	Samsu fresh from still.	Sam Ching Samsu.	Seung Ching Samsu.	Fresh toddy.
	Per cent.	Per cent.	Per cent.	Per cent.
Absolute alcohol by volume -	37.96	38.89	32.87	4.07
	Grams per 100 cubic centimetres.			
Solid extract -	...	0.20	0.40	10.98
Volatile acidity as acetic acid	0.097	0.038	0.037	0.23
Fixed acidity as tartaric acid	Nil.	Nil.	Nil.	0.11
Aldehydes -	...	...	...	Nil.
Furfural -	...	...	...	...
Esters as ethyl acetate -	0.430	0.415	0.375	0.0137
Higher alcohols as amyl alcohol	0.043	0.029	0.021	0.0032

Although it is not possible for the local distillers of samsu to introduce scientific control and adopt the methods practised in Europe it is suggested that some improvements might be made and increased efficiency obtained with the means at present available. The improvements which appear to be feasible are conveniently considered under the following:—Cooking, fermentation, distillation.

Cooking.—It should be possible to adopt a form of steam heated cooker on the lines of the cooker used in parboiling rice at the Bagan Serai Government Rice Mill where a charge of moist rice is subjected to the action of steam under a slight pressure.

In continental practice the rice is gelatinised by heating with steam at a pressure of 4 atmospheres and the water used for soaking the rice is slightly acidified with hydrochloric acid. Thus the period of fermentation is considerably shortened.

Fermentation.—The vessels in which fermentation takes place should be fitted with efficient stirrers and provided with means for aerating the mash during the process. It should be possible to take representative samples of the mash and adopt a comparatively simple test whereby the course of the fermentation could be followed. The percentage of alcohol can easily be determined by the use of an ebulliometer. The conversion of starch to sugar is effected readily by the Chinese wine-cake but the production of alcohol from the sugar is a slower process; it is found efficient in continental practice to add a yeast at a certain stage in the fermentation and it is not unlikely that a similar practice could be adopted by the Chinese distillers, the use of toddy yeast naturally suggesting itself for trial.

Distillation.—It is possible in this connection that the local methods are used obviously as well though it is probable that any changes such as the introduction of more modern apparatus will be more difficult to accomplish. The aroma and flavour of a potable alcoholic beverage are all important and any changes in the distillation apparatus will certainly alter the composition and characteristics of the distillate.

Trials with a small steam heated pot-still have already been initiated and one local distiller is installing a 600 gallon still which is intended for industrial use, it remains to be seen whether it will be possible to blend the samsu obtained and satisfy the taste of those who are accustomed to the spirit made with the former primitive apparatus.

Received for publication 6th February, 1928.

Observations on Oil Palms.

T. D. Marsh.

In a previous paper published in this Journal* the results were given of an experiment in the pollination of the oil palm *Elaeis guineensis* Jacq., carried out at the Government Experimental Plantation, Serdang, during the year 1924.

A summary of the above paper is given below:—

1. An avenue of eight-six oil palms, planted in May, 1922 in rows 9 feet apart at a distance of 30 feet apart in the rows was utilised for a pollination experiment from the time they commenced to flower in August, 1924 until the end of the year 1927. Forty-three palms on one side of the avenue were pollinated artificially, while those on the other side served as controls.

2. The yields of fruit from the two sets of palms were recorded.

3. The records for the year 1927 show a much greater yield of fruit from the pollinated palms than from the control palms.

4. The height, spread and circumference at the base of each palm were recorded and the average measurements of the two sets of palms showed no material differences.

Seven Year's Records

The present paper gives the results of a continuation of the experiment to the end of the year 1930, and shows even greater increase in yield than occurred in 1927 by hand pollinated palms over those naturally pollinated.

The minimum rate of pollination was limited to the artificial pollination of the female inflorescence per palm per month.

Frequently as the records show, additional bunches matured as a result of natural pollination and often the hand

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*Malayan Agricultural Journal Vol. XIV 1926 p 38.

pollinated flowers failed to produce fruit, probably due to wet weather at the time of pollination.

A few bunches of fruit from both sides of the avenue died when approximately half-grown, this appears to be correlated with rainfall and nutrition of the palms; it mostly occurs towards the end of a period of light rainfall, or, during heavy rains following a dry period. More attention will be paid to this problem during future observations.

Basal leaves, which had ripe bunches of fruit harvested from their axils, were not pruned if they were green and apparently still functioning and only those leaves which had commenced to turn yellow were removed.

In addition to showing the effect of artificial pollination on comparatively young palms the observations provide data of considerable interest as regards growth increase, individual yields and variation in type of palms growing under avenue conditions.

TABLE I.

Yields from Pollinated Palms, 1926

Palm No.	No. of mature bunches.	Total weight of bunches. lbs.	ozs.	Total weight of fruits. lbs.	ozs.	No. of fruits.
1	12	267	4	179	3	6,022
3	15	321	8	233	9	7,811
5	16	343	—	229	—	8,217
7	18	305	2	185	8	5,518
9	14	245	6	152	8	5,693
11	10	181	2	112	7	5,796
13	10	129	14	86	6	3,338
15	17	84	6	47	15	3,672
17	15	112	2	67	5	3,094
19	11	177	10	111	10	4,317
21	23	264	14	180	3	6,006
23	20	248	2	166	—	6,509
25	11	87	4	58	7	2,511
27	16	300	2	137	3	6,344
29	4	24	8	16	10	1,195
31	11	200	12	135	15	6,061
33	9	56	14	32	—	1,678
35	10	189	6	136	2	5,298
37	15	282	—	185	12	6,102
39	10	127	14	91	6	3,887
41	5	43	8	29	8	1,238
43	14	181	4	126	13	4,315
45	4	46	2	30	8	1,646
47	17	184	—	127	5	4,523
49	12	137	12	98	3	4,447
51	9	112	4	78	2	3,552
53	7	103	8	69	7	3,512
55	13	166	12	116	13	5,450
57	17	319	14	217	7	8,289
59	8	130	4	96	4	4,059
61	13	129	10	83	9	4,982
63	16	150	—	96	8	4,272
65	19	345	4	244	12	8,599
67	15	249	4	168	2	5,444
69	10	138	4	100	10	4,292
71	23	313	10	208	7	7,300
73	9	181	2	123	5	6,516
75	7	94	—	57	10	2,728
77	9	137	12	95	3	4,858
79	18	224	14	136	3	8,171
81	14	206	14	138	—	7,123
83	9	124	12	83	13	3,930
85	11	151	10	92	—	4,577
Totals	546	7,821	6	5,163	9	212,892

TABLE II.

Yields from Control Palms, 1926.

Palm No.	No. of mature bunches.	Total weight of bunches. lbs.	ozs.	Total weight of fruits. lbs.	ozs.	No. of fruits.
2	10	104	—	37	4	1,065
4	8	62	10	10	5	274
6	2	14	—	7	12	444
8	1	2	10	—	12	68
10	10	44	10	9	—	329
12	9	96	14	12	6	395
14	11	58	4	28	3	1,199
16	5	22	10	10	4	794
18	12	120	14	31	5	902
20	17	102	—	30	6	895
22	4	47	2	26	4	1,013
24	11	87	4	47	7	2.000
26	9	97	6	50	2	2,119
28	13	181	14	42	10	1,630
30	9	32	—	8	5	273
32	17	101	4	47	3	1,904
34	9	37	10	9	6	399
36	7	22	12	7	12	284
38	11	56	4	13	5	524
40	7	44	6	26	10	975
42	6	37	6	15	2	644
44	23	186	—	89	8	2,739
46	3	47	2	26	10	1,168
48	5	33	6	5	14	610
50	6	21	8	3	7	197
52	11	58	10	12	5	345
54	13	101	4	32	5	1,167
56	15	84	4	16	5	510
58	17	217	8	25	9	825
60	12	103	6	12	8	514
62	6	21	12	3	4	250
64	15	88	14	41	5	1,261
66	10	68	12	5	15	472
68	7	22	14	4	8	252
70	6	63	6	16	14	563
72	9	19	14	4	10	136
74	8	48	4	13	8	571
76	17	81	—	18	10	730
78	4	15	14	8	6	445
80	8	66	4	30	4	1,446
82	1	2	4	—	10	8
84	9	57	10	26	5	1,247
86	14	142	12	32	—	2,235
Totals	407	2,926	4	902	5	35,821

TABLE III.

Summary of Table I & II and Comparisons with 1925 Yields.

Particulars.	1925.		1926.	
	Artificially pollinated palms.	Control palms.	Artificially pollinated palms.	Control palms.
Number of palms -	43	43	43	43
Number of productive palms	40	39	43	43
Number of bunches harvested	349	137	546	407
Average number of bunches per fruiting palm -	8.72	3.51	12.70	9.47
Total weight of bunches -	3,116 lbs.	771 lbs.	7,821 lbs.	2,726 lbs.
„ „ „ fruit -	1,951 lbs.	379 lbs.	5,163 lbs.	902 lbs.
Average weight of fruits per yielding palm -	48.77 lbs.	9.72 lbs.	120 lbs.	21 lbs.
Total number of fruits -	97,272	17,158	212,892	35,821
Number of fruits per lb. -	50	45	41.2	39.7

Observations on Table III.

The figures show that there has been a progressive increase in yield from both plots during the year.

Pollinated palms compared with naturally pollinated ones have more than maintained the increase in yield as shown in 1925, without any apparent influence on the health and vigour of the palms. The size of individual fruits from both sets of palms, as shown in the number per pound is greater, and there is also less variation in this respect in the second year's results.

A yield of 120 lbs. of fruit per palm during the year gives a calculated return per acre of 6,600 lbs. of fruit at a planting distance of 30 feet x 30 feet triangular, i.e. 55 palms per acre. This return is exceptionally high for palms of this age and approximates to the estimated production of 9 to 10 year old palms under average plantation conditions. The avenue conditions, together with a sufficient supply of

pollen, are presumably factors which favour the artificially pollinated palms and account for the heavy yields.

The yield from the unpollinated palms is low, but a probable explanation of this, is lack of pollen, owing to the isolated position of the avenue; it being approximately half a mile from the main palm area.

Measurements of Palms.

The following measurements of the palms on both sides of the avenue, taken at the end of the year 1926, are recorded: —

TABLE IV.

Pollinated Palms.

Palm No.	Height.		Spread.		Circumference.		Palm No.	Height.		Spread.		Circumference.	
	ft.	in.	ft.	in.	ft.	in.		ft.	in.	ft.	in.	ft.	in.
1	24	0	35	0	8	0	45	14	0	25	6	6	10
3	24	0	31	6	8	3	47	21	0	31	6	6	8
5	24	0	36	6	8	5	49	20	0	29	6	6	6
7	23	0	36	6	7	6	51	18	0	27	6	6	0
9	21	6	34	0	7	8	53	18	6	27	6	6	4
11	17	6	24	0	8	0	55	20	6	30	0	6	1
13	16	6	27	6	7	8	57	22	0	32	0	7	4
15	15	0	21	6	7	0	59	20	6	36	0	6	10
17	17	0	25	6	6	6	61	16	6	25	6	7	0
19	21	6	30	0	7	8	63	15	0	24	0	6	8
21	20	6	30	0	7	8	65	22	0	32	6	7	7
23	21	0	33	6	7	4	67	22	0	31	0	7	9
25	15	6	24	6	5	6	69	16	0	25	6	6	10
27	24	0	36	0	8	8	71	20	0	29	0	7	2
29	14	6	22	6	6	0	73	15	6	22	0	7	8
31	21	0	36	0	8	0	75	16	0	22	0	8	3
33	20	0	26	6	6	10	77	14	6	20	6	6	7
35	21	0	31	0	7	2	79	14	0	21	6	8	0
37	22	0	33	6	7	9	81	14	0	21	6	7	3
39	17	6	29	0	6	2	83	14	6	21	6	7	8
41	11	0	16	6	5	6	85	16	0	26	0	7	3
43	15	6	28	0	7	4	Totals	798	0	1,211	0	308	10

TABLE V.

Control Palms.

Palm No.	Height.		Spread.		Circumference.		Palm No.	Height.		Spread.		Circumference.	
	ft.	in.	ft.	in.	ft.	in.		ft.	in.	ft.	in.	ft.	in.
2	25	6	36	0	8	10	46	22	6	32	6	8	0
4	25	0	34	0	8	11	48	23	0	31	6	7	9
6	19	0	29	0	7	6	50	19	0	28	6	7	0
8	19	0	27	0	6	10	52	23	0	32	6	8	11
10	23	0	33	0	8	6	54	23	6	34	0	7	7
12	15	6	26	0	7	0	56	24	0	32	0	8	10
14	15	6	23	0	6	5	58	23	0	31	6	8	6
16	18	0	27	0	6	11	60	23	6	31	0	9	0
18	23	0	34	6	9	0	62	19	0	27	6	7	1
20	17	6	26	6	7	8	64	20	6	29	6	7	7
22	18	0	26	6	7	9	66	20	0	27	6	7	10
24	19	0	27	6	8	0	68	15	0	22	0	6	2
26	21	0	30	0	7	6	70	16	0	23	6	6	8
28	21	0	32	6	8	6	72	15	6	24	0	5	10
30	19	0	28	0	7	8	74	15	0	22	6	7	3
32	17	6	26	6	7	5	76	14	0	26	0	7	0
34	17	6	28	0	7	10	78	11	6	19	0	6	1
36	18	0	26	6	7	6	80	15	0	26	6	7	11
38	17	6	27	0	7	0	82	14	0	23	0	8	0
40	16	0	24	0	6	9	84	16	0	22	6	6	6
42	16	0	26	6	6	10	86	14	6	21	6	7	2
44	20	6	27	0	8	7	Totals	809	6	1,194	6	325	7

The measurements recorded in Table IV and V show the following comparisons:—

TABLE VI.

Particulars.	1925.		1926.		Increase in growth during 1926.	
	Pollinated palms feet.	Control palms feet.	Pollinated palms. feet.	Control palms feet.	Pollinated.	Control.
Average height of palm -	15.60	15.67	18.56	18.83	2.96	3.16.
Average spread of leaves (i.e. diameter) -	21.49	21.70	28.16	27.78	6.67	6.08
Average circumference at base of palms -	6.45	6.63	7.19	7.57	0.74	0.94

The measurements summarised above show that the palms are well grown and that there is no appreciable difference in growth between the pollinated and non-pollinated palms.

The increase in growth during the year 1926 is also recorded.

TABLE VII.

MONTHLY RAINFALL FOR 1926 AS RECORDED AT THE GOVT. PLANTATION, SERDANG, SELANGOR.

Month.	No. of days on which rain fell.	Greatest rainfall in 24 hours.	Total rainfall.
		ins.	ins.
January -	18	1.22	5.26
February -	14	1.19	5.07
March -	22	2.33	7.07
April -	24	1.00	6.70
May -	19	3.75	12.80
June -	14	1.64	7.44
July -	7	1.83	4.41
August -	7	.73	1.70
September -	14	1.40	5.76
October -	13	1.64	8.45
November -	16	2.36	10.57
December -	14	2.15	11.80
Totals -	182	3.75	87.03

Summary.

1. The second year's yields of oil palms growing under avenue conditions in an experiment on artificial pollination are recorded and comparisons drawn with the yields of an equal number of palms naturally pollinated.

2. The results show that the large increase in yield due to artificial pollination in 1925 has been more than maintained during 1926.

3. Measurements of height, spread and circumference at the base of individual palms are included, the averages of the figures from each side of the avenue showing little difference in the size of the palms.

4. The increase in growth of the palms during 1926 is given.

The writer is indebted to Mr. E. A. Curtler, who was in charge of this experiment until June, 1926, for all records to that date.

An Ornamental Shade Tree—Muntingia Calabura.

F. S. Banfield.

The tree *Muntingia calabura,* which is a native of tropical America, has become most popular locally with Europeans and Chinese as a shade tree for gardens and is commonly known as the West Indian Cherry.

Description.

It is a medium-sized tree, rarely exceeding thirty feet in height. When mature it is umbrella-shaped so that it assumes a pleasing outline when seen from a distance. Its branches are closely covered with light foliage, which adds to its attractiveness.

The leaves are alternate, lanceolate in shape with a semi-cordate base; they are 3 to 4 inches long 1.25 to 1.50 inches wide. Beneath they are softly hairy and sticky, due to the presence of glandular hairs.

The white flowers are bisexual and produced in pairs in or above the axils of the leaves; each is 0.75 in. in diameter.

The fruit, which is produced on a peduncle 1 inch long, resembles a cherry and is about 0.50 in. in diameter. It is deep pink in colour and contains a quantity of sweet watery pulp, which is edible.

Propagation.

The propagation of this tree has for some time been a matter of difficulty. Originally, trees were raised solely by means of root-suckers, which were collected at the bases of mature trees. This is, however, an uncertain and somewhat unsatisfactory method when a large number of trees are required.

Cuttings of half-ripened shoots will usually produce roots if placed in a suitable situation and kept free from the attacks of white-ants. Such cuttings will also root in pure sand providing they are kept in a shady and moist position.

Considerable success has attended the efforts at propagating this tree recently at the Government Experimental Plantation, Serdang. It is found that an average fruit contains about two thousand minute seeds, which are difficult

to separate from the pulp by ordinary means. When seed is required for planting a few ripe fruits are taken and the pulp from them squeezed into a glass of water. The watery pulp thus obtained is then poured uniformly over specially prepared soil in a seed box. The soil should be well screened beforehand and contain plenty of sand. In a month or so from the time of sowing, signs of germination are visible and it is then necessary to use care in watering, otherwise the small seedlings will damp off. When they are large enough to handle the seedlings may be potted off into pots containing a light soil and placed in a shady position for a few days. When the seedlings are three inches high they are transferred to bamboo pots or baskets in which they remain until they are large enough for planting out. For the final potting a rich mixture containing plenty of humus matter should be used as this enables the seedlings to make rapid and uninterrupted growth. The young plants are hardened off before they are removed for planting.

Planting.

A suitable distance for planting this tree is 20 to 25 feet apart. Within six months from planting, branches are produced in quantity and, if it is desired to train the trees into a good shape, frequent attention must be given to cutting away superfluous growth in order to encourage the full development of the main stem. When the trees are two years old all lower branches should have been removed to a height of about six feet.

The soil should be turned periodically below the trees to encourage root-development. Should it be desired to force the trees to their maximum size at an early date, artificial manure may be applied. For this purpose sulphate of ammonia is recommended, because it is readily obtainable and easily applied. This fertiliser is added to the soil at intervals of six months, commencing with the advent of the rainy seasons. A suitable application is a dessertspoonful of sulphate of ammonia, this quantity being applied once a year to each tree. The fertiliser should be mixed with fine soil to ensure good distribution over the roots, care being taken not to apply the mixture near to the stems of the trees.

General.

Muntingia calabura has a number of points favourable to its use as an ornamental shade tree. It grows very

quickly; its foliage is dense and affords excellent shade. Certain seedling trees, six months old, planted out to form an avenue at the Government Experimental Plantation, Serdang during October, 1926 have attained a height of 22 feet at the present time (February, 1928) i.e., sixteen months from time of planting. Several of these trees have a spread of 12 feet from the trunk, which shows a circumference of 16 to 18 inches at 3 feet from the ground.

In common with other trees of the Natural Order Tiliaceae, the species under reference has a fibrous bark, the branches rarely breaking as a result of heavy winds. Further, the leaves are comparatively small and produce hardly any litter when they are shed. They fall during most months of the year but, as in the case of the majority of ornamental trees in the Peninsula, the largest amount of shedding takes place in February and early March, that is during the short dry season.

The tree grows well at low elevations and does not require other than ordinary soil. It prefers however a heavy loam, yet makes good growth even in sandy soils.

The species is particularly suitable for avenue planting, also it is likely to be of considerable use as a shade tree for cattle, pigs and poultry. At a planting distance of 20 feet by 20 feet square, almost complete overhead shade is formed within one year from the time of planting the seedlings.

The fruit is eaten by birds, in particular the Yellow-vented Bulbil or "merbah" (*Pycnonotus goiavier analis*).— one of the commonest garden birds in this country. It is also eaten by bats and it is stated that the tree is sometimes unpopular with Chinese for this reason.

Publications of the Department of Agriculture.

The following publications, except those out of print, may be obtained on application to the Office of the Secretary for Agriculture; and the Malay States Information Agency, Malaya House, 57 Charing Cross, Trafalgar Square, London.

A remittance to cover the cost should accompany applications; otherwise the Journals will be sent by post, Cash on Delivery, where that system is in force.

1. The Agricultural Bulletin F.M.S.

Vols. I—IV (1913-16) VIII & IX (1920-21) price $5.00 per volume.
Vol. V (1917) Nos. 1, 2, 3, 5 & 6 ,, 2.50 per set.
Vol. VII (1919) ,, 2—6 ,, 4.50 per set.

(Vol. VI is out of print.)

2. The Malayan Agricultural Journal (continuing the Agricultural Bulletin) Published monthly.

Vol. X (1922) to Vol. XII (1924) } Price $5.00 per volume.

Vol. XIII (1925) to Vol. XV (1927) } Price $5.00 per volume or 50 cents per single number.

Back numbers of Vols. 1.—XII will not be sold singly.

3. The Handbook of Malayan Agriculture, price $1.00.

Current numbers of the Malayan Agricultural Journal and the Handbook may be purchased from the Singapore Branch of Messrs. The Federal Rubber Stamp Co.

4. *Special Bulletins.*

1. Notes on *Termes Gestroi* and other species of Termites found on Rubber Estates in the Federated Malay States, by H. C. Pratt, 1909, 20 cts.
2. Root Disease of *Hevea Brasiliensis*, by W. J. Gallagher. C
3. Observations on *Termes Gestroi* as affecting the Para Rubber Tree and methods to be employed against its Ravages, by H. C. Pratt, 1910, 20 cts.
4. *Brachartona catoxantha, Hamps*, by H. C. Pratt, 1909. C
5. The Extermination of Rats in Rice Fields, by W. J. Gallagher, 1909. C
6. Branch and Stem Disease of *Hevea Brasiliensis*, by W. J. Gallagher, 1909. C
7. Coffea Robusta, by W. J. Gallagher, Government Mycologist, 1910, 20 cts.
8. The Cultivation and Care of the Para Rubber Tree (in Malay) 1910. C
9. Die-Back Fungus of Para Rubber and of Cacao, by K Bancroft, 1911. C
10. A Lecture on the Para Rubber Tree, by W. J. Gallagher 1910. C
11. Coconut Cultivation, by L. C. Brown, 1911 C
12. Padi Cultivation in Krian, by H. C. Pratt, 1911. C
13. A Root Disease of Para Rubber, *Fomes Semitostus*. by K. Bancroft. 1912, 20 cts.

C = Cancelled

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